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AN INDEX OF THE PHYSICAL VOLUME OF PRODUCTION

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III. MANUFACTURE, 1899-1919 (*concluded*)

THE PURPOSE AND NATURE OF THE ADJUSTED INDEX

THE unadjusted index of physical production for manufacture, developed in the November issue of the REVIEW, discloses highly significant differences between the rates of increase of physical production in agriculture, mining, and manufacture. It also throws considerable light upon the year-to-year fluctuations in output both in manufacture alone and in manufacture

compared with agriculture and mining. But the extent of the year-to-year fluctuations is obscured in the unadjusted index by the element of normal growth which affects the index over longer periods. Since interest frequently attaches mainly to these year-to-year fluctuations — to the degree to which physical production runs above or below the normally expected volume — an index is needed which will take normal growth into account and will express simply the fluctuations of production above and below normal in each succeeding year. Such a device is the adjusted index.

TABLE XXVI. — SECULAR TREND FOR ANNUAL SERIES INDICATIVE OF PHYSICAL PRODUCTION FOR GROUPS OF MANUFACTURES, 1899-1913

Group and series	Unit	LINE OF SECULAR TREND			Normal volume 1913	Normal annual increase
		Equation	Period for which fitted	Origin		
I. FOOD:						
Wheat — consumed	Mill. bushels	$y = 16.59x + 521.2$	1899-1913	1906	637.2	16.59
Cattle — received	Mill. animals	$y = 0.080x + 8.500$	1899-1913	1906	9.063	0.080
Hogs — received	Mill. animals	$y = 0.092x + 18.81$	1899-1913	1906	19.46	0.092
Sheep — received	Mill. animals	$y = 0.476x + 10.35$	1899-1913	1906	13.68	0.476
Sugar — produced	Mill. pounds	$y = 253.6x + 6455$	1899-1913	1906	8230	253.6
II. TEXTILES:						
Cotton (including linters) — consumed	Thous. bales of 500 lbs.	$y = 137.2x + 4534$	1899-1913	1906	5495	137.2
Wool — consumed	Mill. pounds	$y = 9.403x + 474.5$	1899-1913	1906	540.3	9.403
Fibers and textile grasses — imported ..	Thous. long tons	$y = 8.246x + 306.7$	1899-1913	1906	364.4	8.246
Silk — imported	Mill. pounds	$y = 1.398x + 20.23$	1899-1913	1906	30.01	1.398
III. IRON AND STEEL:						
Pig iron — consumed	Mill. long tons	$y = 1.130x + 21.65$	1899-1913	1906	29.56	1.130
IV. LUMBER:						
Lumber — produced	Mill. M board feet	$y = 0.015x + 44.15$	1904-1913	1908-09 ^a	44.22	0.015
VII. LIQUORS:						
Liquors, distilled — produced	Mill. gallons	$y = 4.980x + 143.3$	1899-1913	1906	178.2	4.980
Liquors, fermented — produced	Mill. barrels	$y = 2.040x + 52.25$	1899-1913	1906	66.53	2.040
VIII. CHEMICALS:						
Cotton seed — manufactured	Thous. short tons	$y = 148.5x + 3520$	1899-1913	1906	4560	148.5
Zinc and lead pigments — produced ...	Thous. short tons	$y = 3.655x + 75.87$	1899-1913	1906	101.4	3.655
Flaxseed — produced	Mill. bushels	$y = -0.621x + 24.15$	1901-1913	1907	20.43	-0.621
Petroleum — marketed	Mill. bbls. of 42 gals.	$y = 14.56x + 158.8$	1901-1913	1907	246.2	14.56
Coke — produced	Mill. short tons	$y = (3.499) (1.211) a$	1899-1913	1906	13.34	^b
Sulphuric acid — produced	Thous. short tons	$y = 752.2x + 2482$	1899-1914 ^f	1906-07	3460	150.4
Explosives — produced	Mill. lbs.	$y = 86.34x + 361.3$	1899-1914 ^g	1906-07	473.6	17.27
IX. STONE, CLAY, AND GLASS:						
Lime — burned and sold	Thous. short tons	$y = 120.2x + 2902$	1899-1913	1906	3743	120.2
Glass sand — produced	Thous. short tons	$y = 76.20x + 1200$	1902-1913	1907-08 ^a	1619	76.20
Clay (raw) — produced	Thous. short tons	$y = 109.4x + 1846$	1899-1913	1906	2612	109.4
X. METALS, NON-FERROUS:						
Copper — consumed	Mill. pounds	$y = 28.98x + 585.5$	1900-1913	1906-07 ^a	773.9	28.98
Zinc (primary) — consumed	Thous. short tons	$y = 14.81x + 209.9$	1899-1913	1906	313.6	14.81
Lead (primary) — consumed	Thous. short tons	$y = 10.84x + 337.5$	1899-1913	1906	413.4	10.84
Gold — used in manufactures and arts. .	Thous. fine ounces	$y = 85.21x + 1632$	1899-1913	1906	2228	85.21
Silver — used in manufactures and arts	Mill. fine ounces	$y = 1.337x + 22.57$	1899-1913	1906	31.93	1.337
XI. TOBACCO:						
Tobacco and snuff — produced	Mill. pounds	$y = 11.33x + 379.9$	1899-1913	1906	459.2	11.33
Cigars — produced	Bill. cigars	$y = 0.073x + 6.819$	1901-1913	1907	7.258	0.073
Cigarettes — produced	Bill. cigarettes	$y = (5.636) (1.158) a$	1901-1913	1907	13.61	^c
XII. VEHICLES:						
Freight R.R. cars — produced	Thous. cars	$y = 0.725x + 142.5$	1899-1913	1906	147.5	0.725
Passenger R.R. cars — produced	One car	$y = 138.3x + 2661$	1899-1913	1906	3629	138.3
Passenger automobiles — produced ...	Thous. cars	$y = (98.08) (4.689) a$	1899-1919 ^f	1909	337.7	^d
Auto trucks — produced	Thous. cars	$y = (4.037) (7.572) a$	1899-1919 ^f	1909	20.39	^e

a. Midway between the two years indicated.
b. Shows annual increase of 21.1 per cent.
c. Shows annual increase of 15.8 per cent.
d. Shows annual increase of 36.2 per cent.

e. Shows annual increase of 49.9 per cent.
f. Fitted to census years 1899, 1904, 1909, 1914, 1919.
g. Fitted to census years 1899, 1904, 1909, 1914.

TABLE XXVII.—PERCENTAGES OF ACTUAL ITEMS TO ORDINATES OF SECULAR TREND OF ANNUAL SERIES INDICATIVE OF PHYSICAL PRODUCTION FOR GROUPS OF MANUFACTURES, 1899-1919

Year	I. FOOD AND KINDRED PRODUCTS					II. TEXTILES AND THEIR PRODUCTS				III IRON AND STEEL	IV LUMBER	VII. LIQUORS AND BEVERAGES		VIII. CHEMICALS AND ALLIED PRODUCTS				
	Wheat, ap- parent con- sump- tion	LIVE STOCK Receipts at seven cities			Sugar, total supply	Cotton (includ- ing lin- ters), ap- parent con- sump- tion	Wool, ap- parent con- sump- tion	Fibers and textile grasses (includ- ing flax), imports of un- manu- factured	Silk, imports of un- manu- factured	Pig Iron, ap- prox- imate con- sump- tion	Lumber, esti- mated cut	Liquors, distilled, produc- tion	Liquors,* fer- mented, produc- tion	Cotton seed, manu- factured	PAINTS AND VARNISH		Petro- leum, mar- keted produc- tion	Coke, by- product
		Cattle	Hogs	Sheep											Zinc and lead pig- ments, produc- tion	Flax- seed, produc- tion		
1899	87	85	98	97	99	103	81	93	130	100	...	90	96	100	80	69	135	99
1900	81	90	102	94	92	99	100	91	82	88	...	93	98	92	91	62	112	97
1901	110	95	111	98	108	94	91	97	103	101	...	105	96	114	85	91	97	88
1902	101	102	94	109	92	102	107	118	107	108	...	104	101	112	100	107	103	86
1903	101	108	90	108	112	102	110	103	91	99	...	110	101	105	110	102	100	95
1904	101	104	95	102	96	93	100	103	119	86	98	101	100	104	110	90	102	109
1905	124	109	102	107	98	103	116	108	103	113	99	107	98	93	114	112	104	120
1906	117	110	102	105	101	108	104	98	92	118	104	102	105	109	120	103	88	130
1907	88	112	103	91	106	107	103	100	82	115	104	114	108	70	120	107	105	133
1908	93	102	120	87	95	93	85	95	87	67	95	83	104	96	90	110	103	82
1909	113	105	96	87	102	105	114	111	101	103	101	84	96	82	101	113	98	101
1910	98	103	77	101	101	94	115	80	98	105	101	96	98	100	83	57	103	95
1911	90	97	103	106	95	90	86	82	96	87	97	104	101	116	86	89	102	86
1912	100	90	102	104	100	101	96	113	103	104	102	103	96	104	109	133	96	101
1913	96	87	102	103	101	107	92	107	114	104	100	104	98	106	96	87	101	95
1914	101	79	94	94	105	105	99	106	98	76	92	95	97	123	102	69	102	70
1915	112	86	107	76	106	105	106	103	113	94	86	70	85	87	130	73	102	72
1916	62	100	128	77	107	124	144	127	119	118	90	129	81	90	121	77	104	80
1917	72	120	106	64	105	128	114	101	122	112	81	140	82	83	121	51	110	78
1918	101	137	128	75	91	122	113	94	132	110	72	85	66	84	113	77	112	75
1919	93	127	126	87	101	100	121	79	145	85	77	48	35	77	118	53	113	60

* Figures are for fiscal years ending June 30.

Normal production for each year in each line of manufacture is defined, in the construction of the adjusted index, in terms of the general trend of output over a considerable period. The period adopted for manufacture is the 15-year span from 1899-1913. Normality is the persistent tendency of these pre-war years. Industrial expansion or contraction during the war to a degree not indicated by pre-war tendencies is thus regarded as a departure from normal. Loss of such disproportionate war-time expansion — or relief from such unwonted contraction — constitutes merely a return to normal output. The volume of physical production in any year is normal when it conforms to pre-war tendencies.

The general tendencies of pre-war production find expression in the so-called lines of secular trend. These lines are merely a device for the exact determination of persistent tendencies. Each line implies for each year an output which is said to be normal.¹ The actual recorded output of the year is readily expressed as a percentage of the normal or "expected" figure. Percentages above 100 in this way indicate actual production in excess of normal production; percentages under 100, actual production in defect of normal.

¹ This output is the "ordinate of secular trend" for the year in question.² See pp. 333-335 of the November REVIEW.

The adjusted index for manufacture is an arithmetic mean of the percentage relatives obtained, as indicated, by referring actual output as given in the available statistical series to output normally indicated. In obtaining the index, the various series of relatives are given the same weights and combined in the same fashion as in the construction of the unadjusted index. The index, thus derived, takes the form of a series of items, now above, now below, 100 or normal. The growth element in both the individual series, and the final index secured from them, is entirely eliminated; the year-to-year fluctuations appear in clear relief.

THE ADJUSTED INDEX

As already indicated, the first step in the development of the adjusted index is the determination of the lines of trend for the thirty-three original series. These lines of trend appear in the individual diagrams of Charts XXI, XXII, and XXIII of the November installment of the Index. Their equations, together with the annual increments and 1913 items which these equations imply, are given in Table XXVI. As might be expected, the lines take a wide variety of courses.² In a few cases, the trends of the series are ill-defined. Violent fluctuations from year to year conceal the underlying tendencies. Moreover, the period from 1914 to

TABLE XXVII. — PERCENTAGES OF ACTUAL ITEMS TO ORDINATES OF SECULAR TREND OF ANNUAL SERIES INDICATIVE OF PHYSICAL PRODUCTION FOR GROUPS OF MANUFACTURES, 1899-1919

Year	IX. STONE, CLAY AND GLASS PRODUCTS				X. METALS AND METAL PRODUCTS OTHER THAN IRON AND STEEL					XI. TOBACCO MANUFACTURES			XII. VEHICLES FOR LAND TRANSPORTATION			
	Cement\$ (Port-land), production	Lime, burned and sold in U. S.	Glass sand, production	Clay (raw), production	Copper, apparent consumption	Zinc (primary), apparent consumption	Lead (primary), apparent consumption	Gold, used in manufactures and arts	Silver, used in manufactures and arts	Tobacco and snuff, production	Cigars,† production	Cigarettes,† production	STEAM RAILROAD CARS		AUTOMOBILES	
													Freight cars, production	Passenger cars, production	Passenger automobiles, production	Auto trucks, production
1899	...	94	...	78	...	117	86	93	92	98	79	215	87	77	...	...
1900	...	87	...	103	90	82	99	96	91	96	88	161	84	89	...	...
1901	...	99	...	105	90	104	96	96	89	97	96	117	99	104	...	...
1902	...	107	121	103	121	101	113	104	112	104	96	110	116	92	...	...
1903	...	101	96	108	108	93	98	102	108	102	104	107	109	89	...	...
1904	...	102	92	93	94	100	101	95	103	99	101	95	43	90	102	77
1905	...	107	105	104	107	103	106	104	112	100	101	87	115	99	107	78
1906	...	110	100	110	119	105	112	116	97	103	106	93	164	116	112	78
1907	...	102	102	112	81	101	104	115	102	99	107	93	192	191	118	79
1908	...	88	88	83	76	90	80	84	94	101	94	88	47	56	124	80
1909	...	107	84	99	105	106	99	96	105	104	96	90	60	89	130	81
1910	...	104	105	104	107	91	99	102	89	105	97	99	117	133	136	98
1911	...	97	105	91	95	99	98	96	109	97	99	103	42	103	109	118
1912	...	97	95	101	101	114	96	99	98	97	98	112	97	85	144	162
1913	...	96	111	101	105	94	101	100	97	97	104	114	126	77	137	115
1914	...	87	96	81	77	91	106	95	88	94	98	107	66	89	118	83
1915	...	91	106	84	125	106	98	76	86	92	89	98	47	48	131	162
1916	...	99	109	100	166	128	107	99	89	94	94	120	86	45	175	131
1917	...	90	101	102	148	111	112	99	73	96	100	144	93	47	150	124
1918	...	74	109	94	182	109	106	95	84	96	92	134	72	36	58	147
1919	...	67	82	72	122	76	95	126	...	82	89	136	103	9	77	136

† Weighing more than 3 pounds per thousand.

‡ Weighing not more than 3 pounds per thousand.

\$ Omitted because the relative importance of the series changed radically during the period.

1918 is marked naturally by extraordinary disturbances in a number of lines. Nevertheless, viewing the series as a whole, the assumption of persistent tendencies in output during the period 1899-1913 seems fully warranted. These persistent tendencies toward expansion or decline are expressed in the lines of secular trend.

Reduction of the items of the original series to percentages of "normal" is a simple operation when "normal" is taken to be for each year the ordinate of the series' line of secular trend. The percentage relatives obtained by this step are presented for all thirty-three series in Table XXVII.

The adjusted index is derived from the series of relatives by steps exactly paralleling those taken in the construction of the unadjusted index. Indices for individual industries are secured from series representing single commodity lines. Indices for groups of industries are developed by combining single industry indices. Finally, the index for all manufacture emerges when the group indices are consolidated. Throughout the computations, the weights employed are those derived in the exhaustive analysis of manufacturing data for census years.¹ The arithmetic mean is used exclusively in the averaging, since there are no explicit reasons for adopting a more technical device. The adjusted index

for manufacture finally appears in a form corresponding exactly to that of the adjusted indices for agriculture and mining.

The adjusted index for manufacture for the period 1899-1919 is given in Table XXVIII and shown graphically in Chart XXVI. The year-to-year fluctuations of the physical volume of manufacture are striking. Manufacturing output was relatively large in 1902, 1905-07, 1909, 1912, 1913, and 1916-18. It was relatively low in 1900, 1904, 1908, 1911, 1914, 1915, and 1919. The cyclical character of the movement is marked, and the range of fluctuation, wide. The ups and downs of the economic cycle find a complete counterpart in the variations of physical production in manufacture.

THE ADJUSTED INDEX BY A SIMPLIFIED METHOD

The unadjusted index is obtained, by the methods employed thus far, only after an extended analysis. Determination of the lines of secular trend for the many original series involves difficult choices of period and line as well as laborious computations. A simpler method of obtaining an adjusted index is much to be desired.

Such a method is disclosed by further analysis of the unadjusted index. Each of the unadjusted indices of

¹ See November REVIEW, pp. 316-320.

agriculture, mining, and manufacture shows a characteristic trend. This trend is a composite of the persistent tendencies of the several original series upon which the unadjusted index is based. The line of trend of the index is readily ascertained. From year to year, the

anal method. The general parallelism of the two is enough to dispose of all doubts. For most of the period the indices differ by one point or less. In only two years do the indices diverge as much as three points. Analysis of the causes of these divergences conveys the

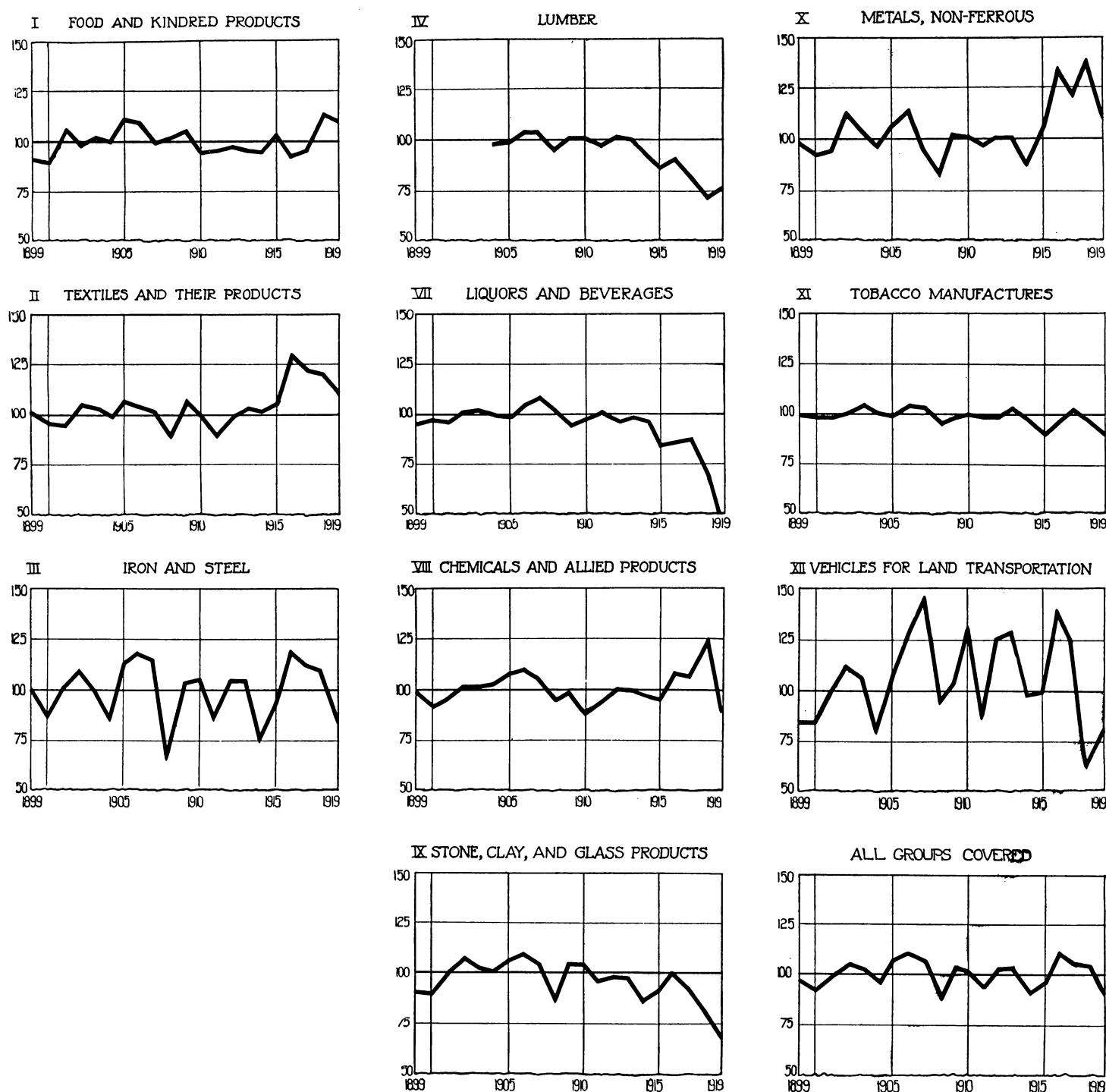


CHART XXVI. — ADJUSTED INDICES OF PHYSICAL PRODUCTION FOR MANUFACTURE AND TEN GROUPS OF MANUFACTURES, 1899-1919

index fluctuates about this line. If the index item of each year is expressed as a percentage of the corresponding ordinate of the secular trend of the index, this new series of relatives is a substitute adjusted index.

Questions may fairly be raised concerning differences in the index secured by the two methods. The adjusted index obtained by the original method being at hand, comparison is not difficult. In Table XXVIII the adjusted index for manufacture, derived by the simplified method, is shown beside the index obtained by the origi-

impression that the index secured by the simpler method is fully as trustworthy as the other for the period covered.¹ The trend of manufactures as a whole is apparently stable and reliably ascertainable. If this is so, the case for the simpler method of getting the adjusted index is conclusive. Results essentially identical are obtained by much less laborious steps.

¹ The divergences arise largely from difficulties experienced in obtaining satisfactory lines of secular trend for some of the individual series during the earlier years of the period.

TABLE XXVIII. — ADJUSTED INDEX OF PHYSICAL PRODUCTION FOR ALL MANUFACTURE AND FOR TEN GROUPS OF MANUFACTURING INDUSTRIES, 1899-1919
(Ordinates of Secular Trend, 1899-1913 = 100)

Year	All manu- facture *	All manu- facture ‡	I. Food	II. Textiles	III. Iron and steel	IV. Lumber †	VII. Liquors	VIII Chemicals §	IX. Stone, clay and glass	X. Metals, non-ferrous	XI Tobacco	XII Vehicles
1899.....	99	97	91	101	100	...	96	99	91	97	99	85
1900.....	95	92	90	96	88	...	98	92	90	92	98	85
1901.....	100	99	106	95	101	...	97	96	100	94	98	100
1902.....	104	105	99	105	108	...	101	102	107	113	100	112
1903.....	101	102	102	103	99	...	102	102	102	103	104	106
1904.....	94	96	100	99	86	98	100	103	100	97	100	82
1905.....	106	107	111	107	113	99	99	108	106	106	99	108
1906.....	109	110	109	104	118	104	105	110	109	114	104	128
1907.....	106	107	100	102	115	104	108	106	104	95	103	145
1908.....	86	88	102	90	67	95	102	96	87	83	96	95
1909.....	102	103	105	107	103	101	95	99	104	102	98	104
1910.....	100	101	95	100	105	101	98	90	104	101	100	129
1911.....	92	93	96	90	87	97	101	93	96	97	99	88
1912.....	102	102	98	100	104	102	97	101	98	101	99	126
1913.....	102	102	96	104	104	100	98	100	98	101	103	129
1914.....	91	92	95	102	76	92	97	97	86	88	98	99
1915.....	96	97	103	106	94	86	84	95	91	106	91	100
1916.....	109	111	93	129	118	90	85	108	100	133	97	138
1917.....	104	106	96	122	112	81	87	107	93	122	103	125
1918.....	101	104	113	120	110	72	68	124	80	137	98	63
1919.....	90	91	110	112	85	77	36	90	69	111	91	82

* Adjusted Index obtained by expressing the unadjusted index for all manufactures as a percentage of the ordinate of secular trend computed for that index.
† Relative to ordinates of secular trend for 1904-13.

‡ Adjusted Index obtained by taking the weighted arithmetic average of the ten adjusted group indices.

§ Includes explosives and sulphuric acid from 1909 to 1919.

ADJUSTED INDICES FOR IMPORTANT GROUPS OF MANUFACTURING INDUSTRIES

The adjusted index for manufacture as a whole rests upon similar indices for ten important groups of industries. These group indices display characteristics which are singularly interesting and significant, and call for specific comment. The indices are given in full in Table XXVIII and are shown graphically in Chart XXVI.¹

Striking differences appear. For the full period 1899 to 1919, the indices for the food and tobacco groups show the most even courses, and the index for vehicles, by far the most erratic. The index for the iron and steel trade follows very closely, but with wider amplitude, the index for manufacture as a whole. The indices for the textile, chemical, iron and steel, and non-ferrous metal groups rise to extraordinary heights from 1916 to 1918. In contrast, the indices for the lumber, stone and clay, and liquors and beverages groups suffer serious declines between 1913 and 1919. In general, the differences between the indices conform to general impressions regarding the course of manufacturing during the period from 1899 to 1919.

Comparison of the group indices suggests a fundamental question: To what extent are the peace-time fluctuations of physical output in the different groups

essentially simultaneous and of the same general type and degree. The question is best answered by obtaining the "cycles" of the group indices.² These cycles are

¹ In all cases but one, the adjusted group indices are based upon the data employed in constructing the unadjusted index for manufacture — see the November issue. In the case of the chemical group, however, it has been thought advisable to add series for two products the output of which was greatly stimulated by the war. These two series are explosives and sulphuric-acid production. The data on explosives are drawn from *Technical Papers*, 107, 231, and 259, of the United States Bureau of Mines; and the data on sulphuric acid through 1917, from Part II of the United States Geological Survey's report on *Mineral Resources*, and for 1918 and 1919, from the *Engineering and Mining Journal*, December 28, 1918, and January 17, 1920. The explosives series includes black blasting powder, high explosives other than permissible, and permissible explosives. The sulphuric-acid series consists of acids of grades varying from 50° to 66° Baumé, reduced to 50° Baumé acid, in short tons. The two series follow:

Year	Explosives million lbs.	Sulphuric acid thous. sh. tons
1899	201.9 *	1548
1904	337.4 *	1869
1909	455.6 *	2749
1911		2688
1912	489.4	2876
1913	500.0	3539
1914	450.3	3762
1915	460.9	3868
1916	505.4	5642
1917	582.5	5968
1918	499.1	8640
1919	417.6	4750

* Estimated from census reports.

² The nature of the cycles should be clear to readers of the REVIEW. They consist of the original deviations of the indices reduced to proportions of their respective standard deviations.

TABLE XXIX. — CYCLES OF THE ADJUSTED INDEX OF PHYSICAL PRODUCTION FOR ALL MANUFACTURE AND FOR TEN GROUPS OF MANUFACTURING INDUSTRIES, 1899-1919

(Ordinates of Secular Trend, 1899-1913 = 0; Unit = Standard Deviation)

Year	All manu- facture*	I. Food	II. Textiles	III. Iron and steel	IV. Lumber †	VII. Liquors	VIII. Chemicals	IV. Stone, clay, glass	X. Metals, non-ferrous	XI. Tobacco	XII. Vehicles
<i>Standard Deviation.....</i>	<i>5.8</i>	<i>5.9</i>	<i>5.2</i>	<i>12.8</i>	<i>2.8</i>	<i>3.4</i>	<i>5.6</i>	<i>6.3</i>	<i>7.6</i>	<i>2.3</i>	<i>18.9</i>
1899.....	-.2	-1.5	+.2	0		-1.2	-.2	-1.4	-.4	-.4	-.8
1900.....	-.9	-1.7	-.8	-.9		-.6	-1.4	-1.6	-1.1	-.9	-.8
1901.....	-.1	+1.0	-1.0	+.1		-.9	-.7	0	-.8	-.9	0
1902.....	+.7	-.2	+1.0	+.6		+.3	+.4	+1.1	+1.7	0	+.6
1903.....	+.1	+.3	+.6	-.1		+.6	+.4	+.3	+.4	+1.7	+.3
1904.....	-.9	0	-.2	-1.1	-.9	0	+.5	0	-.4	0	-1.0
1905.....	+1.0	+1.9	+1.3	+1.0	-.5	-.3	+1.4	+1.0	+.8	-.4	+.4
1906.....	+1.6	+1.5	+.8	+1.4	+1.5	+1.5	+1.8	+1.4	+1.8	+1.7	+1.5
1907.....	+1.0	0	+.4	+1.2	+1.5	+2.4	+1.0	+.6	-.7	+1.3	+2.4
1908.....	-2.3	+.3	-1.9	-2.6	-1.8	+.6	-.7	-2.1	-2.2	-1.7	-.3
1909.....	+.4	+.8	+1.3	+.2	+.3	-1.5	-.2	+.6	+.3	-.9	+.2
1910.....	+.1	-.8	0	+.4	+.3	-.6	-1.8	+.6	+.1	0	+1.5
1911.....	-1.3	-.7	-1.9	-1.2	-1.0	+.3	-1.2	-.6	-.4	-.4	-.6
1912.....	+.4	-.3	0	+.3	+.6	-.9	+.2	-.3	+.1	-.4	+1.4
1913.....	+.4	-.7	+.8	+.3	-.2	-.6	0	-.3	+.1	+1.3	+1.5
1914.....	-1.6	-.9	+.4	-1.9	-3.0	-.9	-.5	-2.2	-1.6	-.9	0
1915.....	-.6	+.5	+1.2	-.5	-5.0	-4.7	-.9	-1.4	+.8	-3.9	0
1916.....	+1.6	-1.2	+5.6	+1.4	-3.4	-4.4	+1.4	0	+4.3	-1.3	+2.0
1917.....	+.7	-.7	+4.2	+.9	-6.7	-3.8	+1.2	-1.1	+2.9	+1.3	+1.3
1918.....	+.2	+2.2	+3.8	+.8	-9.9	-9.4	+4.3	-3.2	+4.9	-.9	-2.0
1919.....	-1.8	+1.7	+2.3	-1.2	-8.3	-18.8	-1.8	-4.9	+1.4	-3.9	-1.0

* Cycles of the Adjusted Index obtained by expressing the unadjusted index for all manufactures as a percentage of the ordinate of secular trend computed for that index. † Cycles with reference to secular trend for 1904-13.

given in Table XXIX. Upon the whole, the cycles for the pre-war years exhibit a remarkable similarity. Naturally, during the war, the different groups were affected in diverse ways. The enlargement of output in some lines was as extraordinary as the curtailment of output in others. Under conditions of peace, however, it is clear that the groups tend to move together, presumably under the pervasive influence of the business cycle.

The close correspondence of the individual groups of manufactures with manufacture as a whole may be demonstrated in still another way through the measurement of the correlation existing between the ten group indices and the index for all manufacture. The coefficients obtained in these ten comparisons appear in Table XXXI. Only two of the coefficients are low; but two are extraordinarily high. In general, the coefficients demonstrate a remarkable correlation between the ten groups of manufactures and manufacture as a whole.

Though the similarity of movement among all the groups is impressive, the truly striking feature of the group indices is the remarkable correspondence between the indices for the iron and steel trade and for manufacture as a whole. Output in the iron and steel trade fluctuates much more widely than physical production

in the ten industrial groups combined, but the time and period of the fluctuations is almost identical, and their degrees, in terms of the relative amplitude of fluctuation in the two series, almost exactly equal. The correlation between the two indices is nearly perfect; viz., .98.¹ Apparently, so far as year-to-year fluctuations are concerned, the iron and steel trade is a remarkably accurate barometer of physical production for manufacture as a whole.

THE ADJUSTED INDEX FOR MANUFACTURE COMPARED WITH TWO SIMPLE PRODUCTION SERIES

The adjusted index for manufacture is the result of careful analysis of a substantial number of series taken from numerous independent sources and representing a wide variety of industries. For these very reasons, it is presumed to give a trustworthy picture of the course of physical production. But now that the index is in hand, it is interesting to see whether a like picture may not be obtained by simpler means from single series showing

¹ It may be thought that the high correlation between the indices for the iron and steel group and for manufacture as a whole is due to a predominating influence of the iron and steel group in the construction of the manufacturing index. That this cannot be the case is indicated, however, by the fact that the iron and steel group has a weight of only 19 out of 88 in the construction of the manufacturing index. Still more conclusive is the fact that the correlation between the iron and steel index and the index for manufacture *with iron and steel excluded* is still very high; viz., .85.

production in certain basic industries which may be assumed to vary with manufacture at large. The two series which suggest themselves are bituminous coal and pig-iron production. These series were both employed in the construction of the index of physical production for mining. It remains to be determined how closely the two series individually register changes corresponding to those shown by the index of manufacturing output.

TABLE XXX. — ADJUSTED INDICES AND CYCLES OF PHYSICAL PRODUCTION FOR ALL MANUFACTURE, PIG IRON, AND BITUMINOUS COAL

Year	ADJUSTED INDICES			CYCLES		
	(Ordinates of secular trend, 1899-1919 = 100)			(Ordinates of secular trend = 0; Unit = standard deviation)		
	Manu- facture	Pig iron	Bitumi- nous coal	Manu- facture	Pig iron	Bitumi- nous coal
1899.....	98	102	93	-.3	+.1	-1.0
1900.....	94	95	94	-1.0	-.4	-.8
1901.....	99	101	93	-.1	+.1	-.9
1902.....	104	106	100	+.6	+.4	+.1
1903.....	101	100	102	+.1	0	+.3
1904.....	94	86	95	-.9	-1.1	-.7
1905.....	106	113	102	+1.0	+1.0	+.2
1906.....	109	118	105	+1.5	+1.3	+.7
1907.....	106	114	115	+1.0	+1.0	+2.0
1908.....	87	67	92	-2.2	-2.4	-1.0
1909.....	103	103	101	+.5	+.2	+.1
1910.....	101	104	106	+.2	+.3	+.8
1911.....	93	87	99	-1.1	-1.0	-.2
1912.....	103	104	105	+.5	+.3	+.7
1913.....	103	105	108	+.5	+.3	+1.0
1914.....	92	76	92	-1.4	-1.8	-1.2
1915.....	97	94	92	-.5	-.5	-1.0
1916.....	110	119	101	+1.7	+1.4	+.2
1917.....	106	113	108	+.9	+1.0	+1.0
1918.....	102	110	109	+.3	+.8	+1.3
1919.....	91	85	84	-1.5	-1.1	-2.2

* Standard deviation.

TABLE XXXI. — COEFFICIENTS OF CORRELATION BETWEEN THE ADJUSTED INDEX OF PHYSICAL PRODUCTION FOR MANUFACTURE AND THE TEN GROUP INDICES, 1899-1913

Group	Coefficient of correlation	Group	Coefficient of correlation
Food.....	+.42	Chemicals.....	+.66
Textiles.....	+.84	Stone, clay.....	+.82
Iron and steel....	+.98*	Metals, non-ferrous	+.78
Lumber.....	+.90†	Tobacco.....	+.62
Liquors.....	+.18‡	Vehicles.....	+.69

* The coefficient of correlation between the adjusted index of manufacture, *excluding the iron and steel group*, and pig-iron consumption is +.85.

† For the period 1904-13.

‡ This low coefficient results largely from the fact that production data for the liquors group are for fiscal instead of calendar years.

The comparison is made for the full period from 1899 to 1919, the trends of the three series — manufacturing output, bituminous-coal production, and pig-iron production — being computed for this 21-year span. The cycles of the three series are given in Table XXX. The close correspondence of the cycles is obvious. Upon the whole, pig-iron production more closely parallels manufacturing at large than does bituminous-coal production.¹ The correspondence of pig-iron production with manufacture, when both are adjusted for secular trend, is extraordinary. The correlation coefficient is .97, compared with .75 for bituminous-coal production and manufacture. It is clear that for the period 1899-1919, both pig-iron and bituminous-coal production pass through much the same fluctuations as the output of manufacture as a whole. The former — pig-iron production — appears to give an amazingly accurate picture of the year-to-year fluctuation of physical production in manufacture.

Indices of the physical volume of production have now been constructed for agriculture, mining, and manufacture. The remaining task is to combine these, possibly with the addition of an index for transportation, to obtain an index of physical production for all industry. This task will be undertaken in the January REVIEW.

¹ This may be accounted for by the importance of the railroads in the consumption of coal.